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Water vapor vertical profiles in Mars' atmosphere by SPICAM/MEx solar occultations

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Knowledge of the vertical distribution of water vapor is one of the crucial diagnostics of the Martian water cycle. It gives information on the role played by important water sources and sinks on Mars, as atmospheric transport, phase changes, vertical redistribution associated with clouds. It allows to extract the hygropause height, which is related to the temperature structure of the atmosphere and to the formation of water ice clouds. Other related phenomena, never directly observed but having the potential to influence significantly the water cycle, as delayed condensation (through supersaturation), formation of ice particles, and deposition of water in the layers just below the saturation height, can be studied and analysed.

Due to the difficulty of this kind of measurements, however, observations of H2O vertical profile have been very sparse. Indeed, before Mars Express only two such datasets existed, both with limited spatial and temporal coverage. For this reason, our knowledge on water vapor vertical distribution is mainly based on GCMs. The solar occultation dataset obtained by the SPICAM spectrometer on the Mars Express spacecraft greatly enhances our observational range, being formed by more than 600 orbits with a good seasonal and spatial distribution along the three Martian years of life of Mars Express.

We present the results of the solar occultation campaign in the first part of Martian Year 29. The dataset consists of approximately 140 orbits around the aphelion season, between Ls=50° and Ls=120°. The coverage includes both hemispheres, with a wide range of latitudes (-70° - +70°). This season is especially interesting, because it includes the onset and development of water sublimation from the polar cap in the north, while the southern hemisphere emerges from the polar night, showing minimal water activity. Our dataset is very well suited to study this strong hemispheric asymmetry.
The retrieved water profiles are analysed in detail and compared with the results of the GCM developed at the Laboratoire de Météorologie Dynamique in Paris (LMD-GCM), in order to determine the physical consequences of the observed profiles.